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Benodigdhede vir hierdie vraestel/Requirements for this paper:			
Multikeusekaarte/ Multi-choice cards:		Nie-programmeerbare sakrekenaar/ Non-programmable calculator:	X
Grafiekpapier/ Graph paper:		Skootrekenaar/ Laptop:	

Word ander hulpmiddels toegelaat/ Are other resources allowed?
NEE/ NO

EKSAMEN/TOETS EXAMINATION/TEST:	**November 2015**	KWALIFIKASIE/ QUALIFICATION:	**Hons. B.Sc. in IT, Hons. B.Sc., M.Sc.**
MODULEKODE/ MODULE CODE:	**ITRI626**	TYDSDUUR/ DURATION:	**3 uur/hour**
MODULEBESKRYWING/ MODULE DESCRIPTION:	**Kunsmatige Intelligensie / *Artificial Intelligence***	MAKS/ MAX:	**100**
EKSAMINATOR(E)/ EXAMINER(S):	**DR. J. V. (TINY) DU TOIT**	DATUM/ DATE:	**06/11/2015**
		TYD/TIME:	**09:00**
MODERATOR:	**MNR. H. (HENRY) FOULDS**		

Vraag 1 (Logiese Agente) / *Question 1 (Logical Agents)*

1.1 Definieer logiese gevolgtrekking. / *Define logical entailment.* [3]

$\alpha \vDash \beta \; M(\alpha) \subseteq M(\beta)$. (3 marks)

$\alpha \vDash \beta$ *the sentence* $(\alpha \Rightarrow \beta)$ *is valid*. (3 marks)

$\alpha \vDash \beta \Leftrightarrow$ if the sentence $(\alpha \wedge \beta)$ is unsatisfiable. (3 marks)

1.2 Deur gebruik te maak van ‘n waarheidstabel, bepaal of die volgende twee uitdrukkings logies ekwivalent is: $\neg((A \vee B) \wedge \neg C)$ en $(\neg A \wedge \neg B) \vee C$. / *By using a truth table, determine if the following two expressions are logically equivalent:* $\neg((A \vee B) \wedge \neg C)$ en $(\neg A \wedge \neg B) \vee C$. [12]

A	B	C	$A \vee B$	$\neg$C	$(A \vee B) \wedge \neg C$	$\neg((A \vee B) \wedge \neg C)$	$\neg A$	$\neg B$	$(\neg A \wedge \neg B)$	$(\neg A \wedge \neg B) \vee C$
T	T	T	T	F	F	T	F	F	F	T
T	T	F	T	T	T	F	F	F	F	F
T	F	T	T	F	F	T	F	T	F	T
T	F	F	T	T	T	F	F	T	F	F
F	T	T	T	F	F	T	T	F	F	T
F	T	F	T	T	T	F	T	F	F	F
F	F	T	F	F	F	T	T	T	T	T
F	F	F	F	T	F	T	T	T	T	T

Yes, the two expressions have the same truth values and are thus equivalent. The truth table counts 11 marks for the 11 columns and 1 mark for the conclusion.

1.3 Beskou die volgende Engelse uitdrukkings. / *Consider the following English expressions.*

“It is not sunny this afternoon and it is colder than yesterday.”
“We will go swimming only if it is sunny.”
“If we do not go swimming, then we will take a canoe trip.”
“If we take a canoe trip, then we will be home by sunset.”

Skakel die uitdrukkings om na proposisielogika uitdrukkings en bewys dat “we will be home by sunset.” Toon al die stappe en redenasies duidelik aan. In die bewys kan ook gebruik gemaak word van Modus Tollens wat sê dat as $P \Rightarrow Q$ gegee is dan kan $\neg Q \Rightarrow \neg P$ afgelei word. / *Convert the expressions to propositional logic expressions and prove that “we will be home by sunset.” Show all the steps and* *reasoning clearly. Modus Tollens may also be used in the proof which states that if $P \Rightarrow Q$ is given then $\neg Q \Rightarrow \neg P$ can be deduced.* [14]

Let:

P: “It is sunny this afternoon.” (1 mark)
Q: “It is colder than yesterday.” (1 mark)
R: “We will go swimming.” (1 mark)
S: “We will take a canoe trip.” (1 mark)
T: “We will be home by sunset.” (1 mark)

Thus:

1. $\neg P \wedge Q$ (1 mark)
2. $R \Rightarrow P$ (1 mark)
3. $\neg R \Rightarrow S$ (1 mark)
4. $S \Rightarrow T$ (1 mark)

Query: T

Using (1) and and-elimination:

5. $\neg P$

Using (2) and modus tollens:

6. $\neg P \Rightarrow \neg R$

Using (5) and (6) with modus ponens:

7. $\neg R$

Using (3) and (7) with modus ponens:

8. S

Using (4) and (8) with modus ponens:

9. T (5 marks)

1.4 Kies die korrekte antwoord(e): / *Choose the correct answer(s):* [2]

$P \vee P$ is ekwivalent aan: / $P \vee P$ is equivalent to:

a) P
b) $P \vee P$
c) $\neg\neg P$
d) $P \wedge P$
e) $\neg P \wedge P$

Answer: (a), (b), (c), and (d). (2 marks)

1.5 Kies die korrekte antwoord(e): / *Choose the correct answer(s):* [2]

Die volgende formule $(P \vee \neg Q) \wedge (\neg P \vee \neg Q)$ is: / *The following formula* $(P \vee \neg Q) \wedge (\neg P \vee \neg Q)$ *is*:

a. in terme vorm / *in term form*
b. in disjunkte normaalvorm / *in disjunctive normal form*
c. in konjunkte normaalvorm / *in conjunctive normal form*
d. in atomiese vorm / *in literal form*
e. in predikaat vorm / *in predicate form*

Answer: (b) (2 marks)

Vraag 2 (Eerste-orde Logika) / *Question 2 (First-Order Logic)*

2.1 Definieer die volgende uitdrukkings uit die domein van versamelings: / *Define the following expressions from the domain of sets:*

a) Die enigste versamelings is die leë versameling en dié wat geskep is deur iets by ‘n versameling te voeg. / *The only sets are the empty set and those made by adjoining something to a set.* [3]
b) Die leë versameling het geen elemente wat bygevoeg is nie. / *The empty set has no elements adjoined into it.* [2]
c) Dit het geen effek om ‘n element wat reeds in ‘n versameling is by te voeg nie. / *Adjoining an element already in the set has no effect.* [2]

a) $\forall s\ Set(s) \Leftrightarrow (s = \{\ \}) \vee (\exists x, s_2\ Set(s_2) \wedge s = \{x|s_2\})$. (3 marks)
b) $\neg\exists x, s\ \{x|s\} = \{\ \}$. (2 marks)
c) $\forall x, s\ x \in s \Leftrightarrow s = \{x|s\}$. (2 marks)

2.2 Vertaal die volgende Engelse sinne na Eerste-orde Logika. / *Translate the following English sentences to First-Order Logic.*

a) Only one student failed Artificial Intelligence. [4]
b) No student failed Computer Security but at least one student failed Artificial Intelligence. [4]
c) Every student who takes Artificial Intelligence also takes Security Computer. [4]
d) No student can fool all the other students. [4]

Answers:

a) Only one student failed Artificial Intelligence.

$\exists$x (Student(x) $\wedge$ Failed(x, Artificial_Intelligence) $\wedge$ $\forall$y (Student(y) $\wedge$ Failed(y, Artificial_Intelligence) $\Rightarrow$ x = y)) (4 marks)

b) No student failed Computer Security but at least one student failed Artificial Intelligence.

$\neg\exists$x (Student(x) $\wedge$ Failed(x, Computer_Security)) $\wedge$ $\exists$x (Student(x) $\wedge$ Failed(x, Artificial_Intelligence)) (4 marks)

c) Every student who takes Artificial Intelligence also takes Computer Security.

$\forall$x (Student(x) $\wedge$ Takes(x, Artificial_Intelligence) $\Rightarrow$ Takes(x, Computer_Security)) (4 marks)

d) No student can fool all the other students.

$\neg\exists$x (Student(x) $\wedge$ $\forall$y (Student(y) $\wedge$ $\neg$(x = y) $\Rightarrow$ Fools(x,y))) (4 marks)

2.3 Is die volgende Eerste-orde Logika uitdrukkings geldig? Verduidelik u antwoorde. / *Are the following First-Order Logic expressions valid? Explain your answers.*

a) $\forall$x $\exists$y Loves(x, y) $\Leftrightarrow$ $\exists$x $\forall$y Loves(x, y) [2]
b) $\forall$x Loves(x, Snoopy) $\Leftrightarrow$ $\neg\exists$x $\neg$Loves(x, Snoopy) [2]
c) $\exists$x Loves(x, AmericanIdol) $\Leftrightarrow$ $\neg\forall$x $\neg$Loves(x, AmericanIdol) [2]
d) $\forall$x,y P(x, y) $\Leftrightarrow$ P(y, x) [2]

Answers:

Are these valid? (Remember, valid = always true)\

a) $\forall$x $\exists$y Loves(x, y) $\Leftrightarrow$ $\exists$x $\forall$y Loves(x, y)

No. The question is asking, is “everyone loves someone” the same as “there is at least one person who loves everybody”. While this is satisfiable, it is not valid. (2 marks)

b) $\forall$x Loves(x, Snoopy) $\Leftrightarrow$ $\neg\exists$x $\neg$Loves(x, Snoopy)

Yes. This question is asking, is "everyone loves Snoopy" the same as "there is not a single person who doesn't love Snoopy". These are exactly the same thing. In general, ∀x P(x) and ¬∃x ¬P(x) are equivalent. But one is shorter to write. (2 marks)

c) ∃x Loves(x, AmericanIdol) ⇔ ¬∀x ¬Loves(x, AmericanIdol)

Yes. This question is asking, is "there is at least one person who loves American Idol" the same as "not everybody hates American Idol" (assuming you consider not loves and hate to be the same thing; it sounds better than "not everyone doesn't love American Idol"). These are exactly the same thing. In general, ∃x P(x) and ¬∀x ¬P(x) are equivalent. But one is shorter to write. (2 marks)

d) ∀x,y P(x, y) ⇔ P(y, x)

No. This question is asking, are all predicates P(x,y) the same as P(y,x) (the same statement with arguments reversed). This is not valid (i.e., always true). For example, reversing the arguments isn't important in Sibling(Meg, Chris) and Sibling(Meg, Chris) but is it for Parent(Peter, Meg) and Parent(Meg, Peter). (2 marks)

<u>Vraag 3 (Inferensie met Eerste-orde Logika) / *Question 3 (Inference in First-Order Logic)*</u>

3.1 Skakel die volgende Engelse sinne om na Eerste-orde Logika en bewys met behulp van voorwaardse skakeling dat Ziggy vis eet. Toon al jou stappe en redenasies duidelik aan. / *Convert the following English sentences to First-Order Logic and prove that Ziggy eats fish by using forward chaining. Show all your steps and reasoning clearly.*

KB = All cats like fish, cats eat everything they like, and Ziggy is a cat.

Goal query: Does Ziggy eat fish? [12]

Answer:

1. $\forall x\ Cat(x) \Rightarrow Likes(x, Fish)$ (2 marks)
2. $\forall x, y\ Cat(x) \land Likes(x, y) \Rightarrow Eats(x, y)$ (3 marks)
3. Cat(Ziggy) (1 mark)

Using (1) and (3) with the substitution {x/Ziggy) and Generalized Modus Ponens gives

4. $Likes(Ziggy, Fish)$ (3 marks)

Using (3), (4) and (2) with the substitution {x/Ziggy, y/Fish} and Generalized Modus Ponens gives

5. $Eats(Ziggy, Fish)$ (3 marks)

3.2 Beskou die volgende kennisbasis. Deur gebruik te maak van resolusie, bewys dat Mary nies. Toon al jou stappe en redenasies duidelik aan. / *Consider the following knowledge base. By using resolution, prove that Mary sneezes. Show all your steps and reasoning clearly.*

KB:

1. $\forall w\ Allergies(w) \Rightarrow Sneeze(w)$
2. $\forall y, z\ Cat(y) \land\ AllergicToCats(z) \Rightarrow Allergies(z)$
3. $Cat(Felix)$
4. $AllergicToCats(Mary)$

Goal query:

$Sneeze(Mary)$ [20]

The sentences converted to conjunctive normal form (CNF) are as follows:

1. $\neg Allergies(w) \lor Sneeze(w)$ (2 marks)
2. $\neg Cat(y) \lor \neg AllergicToCats(z) \lor Allergies(z)$ (3 marks)
3. $Cat(Felix)$ (1 mark)
4. $AllergicToCats(Mary)$ (1 mark)

$5. \neg Sneeze(Mary)$ (1 mark)

Resolve (1) and (2) using θ = {w/z}:

$6. \neg Cat(y) \lor Sneeze(z) \lor \neg AllergicToCats(z)$ (3 marks)

Resolve (3) and (6) using θ = {y/Felix}:

$7. Sneeze(z) \lor \neg AllergicToCats(z)$ (3 marks)

Resolve (4) and (7) using θ = {z/Mary}:

$8. Sneeze(Mary)$ (3 marks)

Resolve (5) and (8):

$9. \square$ (3 marks)

TOTAAL/TOTAL: 100

Verwysingsnommer: 8.1.7.2.2